The Impact of Rural Broadband Development: Lessons from a Natural Field Experiment

What Can Rural Broadband Development Accomplish?

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The United States is intensifying its public investment in broadband Internet service for rural areas to an extent that calls for renewed attention to the impacts of investments in telecommunications technology on rural residents and their communities. The American Recovery and Reinvestment Act (ARRA) of 2009 allocated $7.2 billion to extend broadband Internet access in underserved and unserved areas (Pub. L. No. 111-5, Sec. 6001, 2009). Of this, $2.5 billion was expressly set aside for rural communities and administered by the Rural Utilities Service of the U.S. Department of Agriculture as the Broadband Infrastructure Program (BIP). Another $4.7 billion funded the Broadband Technology Opportunities Program (BTOP) run by the National Telecommunications and Information Administration (NTIA). Congressional testimony by the Assistant Secretary of Commerce and the definitions of underserved and unserved areas provided in the initial Notice of Funds Availability (NTIA, 2009) made rural areas a priority of the NTIA program as well (New America Foundation, 2009). BTOP included $200 million for public computer centers and $250 million for programs to support sustainable broadband adoption.

The sustainable adoption program defined an expansive role for broadband Internet in community life. It funded broadband education, awareness, and training through a wide range of community institutions including libraries, health care, education, job-creating agencies, and organizations that support vulnerable low-income, unemployed, and aged populations (Pub. L No. 111-5, Sec. 6001(b), 123 Stat. 512–13., 2009). The NOFA (NTIA, 2009) called for evaluation of the impacts on consumer awareness and adoption of broadband and drew attention to broader effects in the areas of health care, education, children, and employment. Expectations about the educational, civic, health, entertainment, and economic benefits of broadband Internet in rural communities were amplified in a report by the Federal Communications Commission (FCC, 2009) to fulfill a mandate of the 2008 Farm Bill (Pub. L. No. 110-246, Sec. 6112, 122 Stat. 923-1966, Part III.D, 2008) to formulate a comprehensive rural broadband strategy. In the FCC's report, broadband Internet was said to transform the lives of those who enjoy access to it.

Are these reasonable expectations? That is, do federal broadband grants increase adoption, do community education programs have an incremental impact, and with what benefits for rural communities? These questions are addressed here through a study of the impacts of federally funded broadband projects in four rural counties. All four were funded by the Community Connect program to extend rural broadband access and to improve the quality of life for rural citizens (USDA, 2009). One was a Kentucky county participating in the ConnectKentucky program (ConnectKentucky, 2009), providing a preview of community education efforts to promote sustainable broadband in contrast to two other counties in which the infrastructure investments were implemented without a public education component. The Community Connect grant was suspended in a fourth county, allowing it to serve as a control group. Together, the four communities constitute a natural experiment through which the impacts of rural broadband infrastructure investment and sustainable broadband adoption programs can be examined.

Build It and They Will Come. Or Will They?

The underlying assumption of the current initiative was that more rural residents will adopt broadband Internet simply as a result of gaining access to broadband where none existed before and/or upgrading to the 768kbps standard for broadband established by NTIA. Federal grant recipients could extend service to new households themselves and also stimulate the private sector to make its own investments. Federally funded competitive options might also lower prices and further increase penetration in underserved rural areas. This might close the broadband gap between urban (with 66% penetration) and rural residents (with 46%, Horrigan, 2009), a larger gap than that registered three years before (39% urban versus 24% rural, Horrigan & Murray, 2006) despite the near doubling of rural broadband penetration during that time.

However, a competing argument can be made that rural residents do not need or want broadband service and that Internet providers respond to rural market conditions by either not providing access or keeping prices high to offset the costs of serving low-density areas. A GAO study concluded there was no urban-rural difference in broadband adoption after controlling for demographic variables (GAO, 2006). Older, less educated, lower income residents are more common in rural communities than urban ones and these are groups with low levels of broadband adoption. The "middle mile" costs of connecting rural Internet Service Providers (ISPs) to Internet backbone networks raises the cost of rural broadband service to levels well above those of urban areas (Glass, Talluto & Babb, 2003). Indeed, price is the primary reason people do not upgrade to broadband services (Horrigan, 2009). The obvious, if unstated, implication of such findings is that there is nothing to be done: rural residents are just not the sorts of people who need, want or can afford broadband service. Stated differently, the intractable problems of rural poverty, outmigration of the young, and limited educational access might have to be addressed first to fully close the urban-rural broadband gap. Thus, RQ1: Do federally funded broadband networks increase broadband adoption?

However, if rural broadband can be even a partial solution to rural problems the "demography is destiny" argument offered by the GAO study may be both overly pessimistic and circular. That rural broadband users access online education more than urban broadband users (Horrigan & Murray, 2006) is illustrative of a paradox: broadband use could improve levels of educational attainment that in turn might lead to more broadband adoption according to the demographic destiny argument. But how to improve educational attainment without first improving educational access through broadband adoption? Moreover, while demographic variables play an important role in the adoption of basic Internet service in rural communities, their influence on the further adoption of broadband service is rather weak (Gregg, LaRose, Strover et al., 2006; LaRose, Gregg, Strover et al., 2007).

A competing view is that the relative density of home Internet use explains the gap between Internet adoption in urban and rural areas, what economists called "network externalities" (Mills & Whitacre, 2003) and what others referred to as "critical mass" (Korsching, Hipple & Abbott, 2000). If so, the key to closing the rural broadband gap is to "kick start" the adoption process and thereby increase the density of home users to sustainable levels.

A number of factors limiting adoption might be overcome through public education as envisioned in the sustainable broadband adoption component of BTOP. Considering classic notions of innovation diffusion that originated in studies of rural sociology, the relative advantage, trialability, observability, complexity, and compatibility of broadband Internet services also affect their adoption (LaRose et al, 2007). And, if one believes that broadband access is not available, even when it is, one is naturally unlikely to adopt it. Rural residents are more likely to believe that they do not have access than those living in urban or suburban areas (LaRose et al, 2007). but the extent to which these are valid perceptions is unknown.

Thus, the question becomes how to promote sustainable broadband adoption. Grants to extend rural broadband networks might promote adoption through the well-known diffusion of innovation process (LaRose et al, 2007). through which potential adopters learn of innovations from the media or from others in their social circles. However, from this perspective broadband has an observability barrier in that benefits realized by users on their home computers may not be readily apparent to others. Trialability is also a limitation since trial usage in public access locations are typically time-limited while home trials require making arrangements with providers that often include substantial installation fees and equipment purchases. To the untutored user, broadband technology may seem complex or fundamentally incompatible with existing equipment. Finally, the relative advantages of broadband may not be apparent relative to its cost or to individual needs. Thus, concerted public outreach efforts might be needed to stimulate adoption. This is in contrast to innovations, such as the classic example of hybrid seed corn, where the relative advantages of the innovation may be readily observed in ubiquitous spaces open to public view and tried out on a small scale using existing agricultural methods. This leads to the following questions:

RQ2: What impact do broadband education campaigns have on broadband adoption?

RQ3: What impact do federally funded broadband networks and public education campaigns have on a.) awareness of and b.) perceptions of broadband Internet service and c.) intentions to adopt it?

The Economic Benefits of Rural Broadband

In the context of the crisis in which the ARRA was enacted, the economic benefits of rural broadband investments were paramount. There is mounting evidence (reviewed in Katz & Suter, 2009) that broadband infrastructure investments increase employment and the effect has received preliminary confirmation in rural communities (Gillett et al., 2006). Using input-output analysis that incorporated assumptions about the impact of network externalities on service sector employment as well as immediate impacts on construction employment resulting from broadband infrastructure development, it was estimated that ARRA broadband initiatives could create 128,000 additional jobs (Katz & Suter, 2009).

However, the relationship of economic development and broadband development has been examined through economic analyses of the impacts on the productivity of firms and data aggregated across geographic regions while the focus of the ARRA initiatives is on expanding consumer access to broadband. It is not clear how consumer adoption is linked to economic growth. Internet usage on the job was positively related to Internet access in the home (Hollifield & Donnermeyer, 2003) but the direction of the relationship was not established. And, the relationship is not necessarily a positive one. Broadband connections could allow rural residents to hold down jobs with urban enterprises while they continue to reside in rural communities (Katz & Suter, 2009). On the other hand, improved Internet connectivity could facilitate relocation to urban areas through online job searches and social ties with urban dwellers (LaRose et al., 2008), depriving rural communities of valuable human resources. The unexplored link between consumer broadband adoption and economic development reflects a shift in rural economic development from "smokestack chasing" to cultivating rural entrepreneurs (Drabenstott, Novack, & Abraham, 2003). Broadband Internet can enhance economic opportunities in rural areas by stimulating the development of home businesses and telecommuting (LaRose, Gregg, Strover et al., 2006) and by facilitating access to education and training (Horrigan, 2006). That is, the contributions of economic development efforts undertaken by ordinary citizens to improve their own prospects may have been overlooked in prior research. These are conceptualized as personal economic development activities.

RQ4: What is the impact of federally funded broadband networks and community education campaigns on personal economic development intentions?

Broader Social Impacts

Satisfaction with rural living is affected by considerations other than purely economic ones (DeJong & Fawcett, 1981) that emphasize broader dimensions of community life that might be affected by broadband development. The BTOP program emphasizes the medical, educational, and child benefits of broadband, framing an expectation of broad social outcomes that may result from expanded broadband access. Advanced telecommunications can improve rural health care, education, library resources, employment opportunities, social linkages, and government services (Hales, Gieske & Vargas-Chanes, 2000; Schreck & Hipple, 2000; Leistritz, Allen, Johnson, Olsen & Sell, 1997; Hipple & Ramsey, 2000; Abbott & Gregg, 2000). Improved intra-community communication (Fernandez & Dillman, 1979; Herman & Ettema, 2007; Speare et al., 1982) and improved retail options may also affect satisfaction with rural communities (Ayres, Leistritz & Stone, 1992). A national survey (Horrigan, 2009) found that over half of broadband users stated that high speed Internet service was important for health care, government communication, community news, citizen communication, and economic growth in their communities. Community satisfaction might also increase by virtue of improved access to entertainment, education and public services facilitated by broadband access.

Other research suggests limited or null effects. An evaluation of rural telecommunications projects (Hollifield et al., 2000) found that community telecommunication interventions failed to produce the expected effects on the perceived importance of new technologies for family well-being. No relationship between Internet usage and overall community satisfaction or community attachment was found (Hollifield & Donnermeyer, 2003).

The potential negative consequences of broadband development must also be recognized. Rural shoppers might establish new commercial relationships to the disadvantage of rural suppliers, rural employers might be able to tap urban residents for specialized skills to the detriment of local employment opportunities, and the quality of "virtual" employment and social services may be inferior to real ones (Rowley & Porterfield, 1993). Individual well-being may be negatively affected by Internet usage in the short run, a phenomenon called the Internet paradox (Kraut et al., 1998). In an urban study, heavy Internet use was associated with a declining commitment to living in one's local area as well as being less knowledgeable about one's area of residence (Kraut et al., 2002). Hence, a general question about the broader implications of broadband development in rural America is posed:

RQ5: What impact do government funded broadband networks and public information campaigns have on the community satisfaction levels of rural residents?

Research Methods

Overview of a Natural Experiment

The present research took advantage of a "natural experiment" by tracing the impact of rural broadband grants made by the Rural Utilities Service on rural households over a three-year period, 2005-2008 in Huron County, Michigan; Pike County, Kentucky; Zapata County, Texas;

and Zavala County, Texas. The RUS grant was terminated prior to full implementation in Zavala County, providing a control condition in which no rural broadband grant was implemented.

The first wave of the present study came shortly after the initiation of ConnectKentucky (connectkentucky.org), a well-known effort to stimulate the adoption and effective utilization of Internet technology through community education. ConnectKentucky has since become a model for a national effort, ConnectedNation (www.connectednation.org) which aims to extend broadband Internet access throughout the United States. A comparison of the 2008 Kentucky results with those from 2005 and with three other counties receiving RUS grants thus provides information about the impact of efforts to stimulate broadband adoption through coordinated public education campaigns.

Participants

The four communities were selected from among grant recipients in the Community Connect program (USDA, 2009) for their proximity to the home universities of the participating researchers, one each in Michigan and Kentucky and two in Texas. Surveys were addressed to heads of households in the counties in which the grant was awarded. Overall, 57.6 percent of the respondents were female and 42.4 percent male with a mean age of 50.3 (standard deviation = 17. 6) and an average of 12.5 years of education (standard deviation = 3.5). Sixty-eight percent reported they had ever used the Internet and 58 percent were current Internet users.

Community Context

Zavala County, Texas, representing the control condition in the current study, was comparable to the other three communities in that it was nearly all white (see Table 1). Its population was similar in size to Zapata County and both were predominantly Hispanic. The average 2008 unemployment rate was high, but comparable to Huron County's. Zavala had a high degree of rurality (an urban influence code of 9 out of a possible 12 with a score of 1 indicating highest degree of urban influence) in common with Pike and Huron counties and relatively few residents age 65 or over, similar to Pike and Zapata counties. Zavala had by far the highest levels of high school drop outs and households living in poverty and the lowest median income among the four communities. These conditions reflected a history of segregation and exploitation of immigrant farm laborers from Mexico. Blue Moon Solutions was the recipient of the Community Connect grant. Southwestern Bell initiated the first broadband (DSL) service in 2004, reportedly in response to Blue Moon's prospective offering of fixed wireless service. A dispute with community leaders in Crystal City, home to two-thirds of the county's population, ultimately led to the suspension of the grant and the termination of Blue Moon's service in 2006. That left Southwestern Bell, by then AT&T, as the sole broadband provider in 2008.

Blue Moon Solutions was also the Community Connect grant recipient in Zapata County, where fixed wireless service was implemented, making it one of two "broadband grant only" communities. Unlike the other three communities, Zapata County experienced strong population growth during the course of the study thanks to thriving oil and gas and tourism businesses and development-oriented civic leadership. This resulted in the lowest rate of unemployment among the four communities studied, although with high levels of poverty and low levels of education attainment. Prior to Blue Moon's entry in 2005 there were fixed wireless offerings from two local telephone companies and a DSL offering from Southwestern Bell (again apparently instigated by the prospect of wireless competition) that were largely concentrated in the county seat of Zapata. Blue Moon continued to operate throughout the study period, although its market share declined by nearly 25 percent.

Huron County, Michigan, the other broadband grant only community, was the most prosperous of the four in terms of highest median income and the lowest poverty levels, but also had an alarming level of population decline, an aging population, and a high unemployment rate. The local economy, long focused on automobile-centered manufacturing, was in steep decline. Air Advantage LLC, the Community Connect grantee, used the funds to extend fixed wireless service to previously unserved portions of the county. Despite wireless competitors and the expansion of telephone and cable company broadband networks, the company managed to hold market share during the study period and was singled for favorable mention in the FCC's broadband strategy report (FCC, 2009, pp. 23-24).

Pike County, Kentucky, was the largest community in the study although it suffered a population decline in parallel with a long-term downturn in the county's once-dominant coal mining industry. Aside from its nearly all-white ethnic composition, Pike County was roughly comparable to Zapata County in terms of demographic and economic indicators. However, the environment for Internet service was less favorable than in the other three states involved, with considerably lower levels of both Internet and broadband penetration according to Current Population Survey estimates (NTIA, 2008). Southeast Telephone (Setel), in partnership with several local public service entities received the Community Connect grant. Setel offered DSL service in competition with AT&T and local cable and telephone companies. ConnectKentucky, a nonprofit public/private partnership, was active locally with the goals of increasing the technology "comfort level" and adoption of technology in the community and the delivery of technology education and awareness (ConnectKentucky.org).

Table 1 About Here

Procedure

The residents of the Kentucky and Michigan counties were recruited through mail solicitations addressed to heads of household during the spring of 2005 and the spring of 2008. The Tailored Design Method mail survey methodology (Dillman, 2000) was followed. A random sample of residential addresses in the target counties was obtained from a commercial mailing list vendor. A pre-notification letter printed on the letterhead of the participating university from the respondent's home state was sent. This was followed by a questionnaire booklet with a cover letter on university stationery, a self-addressed stamped envelope and a 25-cent incentive. Those who did not respond were sent a follow-up post card and later a replacement questionnaire delivered via certified mail. Self-administered mail surveys were attempted in Zapata and Zavala Counties in 2005. Commercially available lists for Zapata County were deemed to be incomplete and mail surveys were supplemented with surveys distributed directly to households, using census blocks as clusters. Neither the mail nor direct distribution surveys achieved satisfactory response rates and so trained bilingual interviewers conducted door-to-door surveys in non-responding households. The second wave of surveys in Texas counties collected all cases through door-to-door interviews. Individual county-by-wave response rates ranged between 21% and 58%.

Operational measures

Awareness of broadband was assessed with a single question (coded one if yes, zero if no, M = .58 , SD = .49), "Have you ever heard of high speed (broadband) Internet before? These are Internet connections that make email and surfing the Web several times faster than conventional dial up connections." Respondents who previously indicated that they had never used the Internet were routed around this question and were counted as unaware of broadband.

Broadband adoption in the home was determined after first asking respondents who were aware of high speed service whether they currently used it and, if so, where. Those who checked "Home" were counted as home adopters and all others as non-adopters (1 yes, 0 = no, *M* = .25, SD = .43).

Multi-item dependent variable measures were constructed by summing and averaging the component items. Missing data were with mean values but only when fewer than 10 percent of the cases were missing for a component item and only for cases in which no more than a third of the items in an index would be replaced. Broadband intentions were based on a four-item index[i] of future intentions regarding the use of broadband Internet (α = .81, *M* = 3.17, SD = 1.78), rated on a seven-point scale ranging from the very likely (scored as seven) to very unlikely (scored as one). Perceptions of high speed Internet service (α = .75, *M*= 4.84, SD =.95) were rated on 7-point scales ranging from strongly agree (scored 7) to strongly disagree (scored 1) and negatively worded items were reflected. To focus on perceptions most likely to have influenced broadband adoption, the initial set of 21 items was reduced to 11[ii] by retaining only those items that changed significantly ($p < .001$) between the two survey waves. The community satisfaction index had 11 statements (α = .88, *M* = 4.08, SD = 1.18) that were adapted from DeJong & Fawcett (1981) and rated on a seven-point scale ranging from strongly agree (7) to strongly disagree (1). [iii] Personal economic development intentions were five behavioral intention items relating to new business activities and retraining (α = .86, *M* = 2.60, SD = 1.58).[iv]

Treatment condition was a nominal independent variable with the control county (Zavala, Texas) coded as 1. Two counties in which Community Connect broadband grants were implemented but in which there were no extraordinary efforts toward public education, Zapata County Texas (BB Grant B in the tables that follow) and Huron County Michigan (designated BB Grant A), were coded 2 and 3, respectively. Pike County Kentucky, which had both a federal broadband grant and a state-sponsored public education component was coded 4 (Grant + Campaign). The two survey waves corresponding to the prestest (coded 0) and the posttest (coded 1) comprised the other main independent variable. The Internet status of respondents was defined in relationship to their current usage of dial-up and broadband Internet connections in their homes. Thus, Internet users who said they used high speed connections in their homes were classified as broadband users (coded 2) and the rest as dial-up users (coded 1). Those who indicated neither current dial-up nor broadband usage were classified as non-users (coded zero).

Respondents also were asked to indicate the year of their birth and that date was subtracted from the year of the survey to assess age. The years of education completed, excluding kindergarten, were recorded for education. Household income was also determined, but the question yielded unacceptable levels of missing data and so was dropped from the analysis. Preliminary analyses indicated that gender was not significantly related to the dependent variables of interest and so it, too, was dropped from the analysis.

Data Analysis

Broadband awareness and adoption were nominal, binary response variables and so were analyzed using the generalized linear model procedure found in SPSS Statistics 17.0 (SPSS, Inc., 2008) with a logit linking function. The presence of a two-way interaction between treatment condition and wave was tested after controlling for age of respondent and education (both coded in years). Pairwise contrasts were examined using a Bonferroni sequential correction. The remaining dependent variables were interval-level and so were analyzed through analysis of variance in the SPSS general linear model, again with treatment condition and wave as independent variables and age and education as covariates. Where appropriate, Internet status was introduced as third independent variable and three-way interactions were examined to determine if broadband usage in the home had a differential impact on outcome variables between years and within treatment conditions compared to dial-up or non-use.

Results

Research questions 1 and 2 were examined through an analysis an interaction effect on home broadband adoption between treatment condition and year of survey with age and education as covariates. Both the omnibus test (χ^2 (9, N = 2976) = 497.86, p < .001) and the treatment-by-year interaction were significant (χ^2 (7, N=2976) = 195.42, p < .001). The interaction effect is examined further in Table 2. Compared to the reference condition of the pretest survey in the control community (in which the Federal broadband grant was withdrawn) the initial level of broadband penetration was about equal to the 10 percent found at the outset in the control community in the community with both a grant and a public education campaign (Grant + Campaign) and in one of the grant only (BB Grant A) conditions, but significantly lower in the other community with only a broadband grant (BB Grant B). At the time of the posttest, the Wald chi-squares were significantly different from the reference condition (the pretest in the control community) in the two broadband grant-only communities. However, At the time of the posttest in the control condition, penetration increased to 22 percent for an odds ratio (the probability of having broadband divided by the probability of not having it) of 2.5 to 1. Broadband penetration in a nearby county in which the Federal grant was implemented also increased between years, from 18 percent to 23 percent, but the difference was not significant and the relative change in odds ratios was both smaller (2.560/1.837 = 1.40) than in the control county and less than the 2 to 1 ratio generally considered to constitute a meaningful difference. A larger increase was found in a second county in which a Federal grant was enacted, from 15 percent to 40 percent, for a greater relative increase in the odds of having home broadband than the control condition (5.786/1.515 = 3.8). The largest increase was in the Kentucky county in which a public information campaign was also present, from 12 percent penetration on the pretest to 45 percent after three years, a substantial relative increase in the odds of having broadband in the home (7.033/1.141 = 6.16). Thus, the first research question yielded mixed results. The implementation of a Federal broadband grant alone had an effect on broadband penetration in one community but not another and broadband penetration also increased in a control condition in which the federal grant was suspended. Regarding research question 2, the combination of a Federal grant and community education had an incremental effect on adoption over and above that found in the best case where a Federal grant had been implemented and also in comparison to the control condition.

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Table 2 About Here

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Impacts on awareness of broadband service, research question 3a, are examined in Table 3, substituting broadband awareness as the dependent variable in the model of broadband adoption described above. The omnibus test was significant l (χ^2 (9, N=2976) = 1070.31, p < .001) as was the treatment-by-year interaction (χ^2 (7, N=2976) = 150.194, p < .001). Initial awareness levels in a nearby county (BB Grant B) with a similar demographic profile were no different than the 40 percent level in the control county, but awareness levels at the pretest were significantly higher in the other two counties. Awareness increased significantly at the pretest in the control county, to 53 percent, but none of the other year-over-year changes in awareness were significant and the odds of being aware of broadband service were raised by less than a two-to-one margin in each case. So, in answer to question 3a, the implementation of Federal broadband grants had no significant impact on awareness of broadband service. There was also no indication of an incremental impact on awareness in the community where the broadband infrastructure grant was combined with a community education campaign.

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Table 3 About Here

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An analysis of variance of broadband perceptions with a two-way interaction specified for treatment condition and survey year and age and education as covariates was significant overall (F (9, 1660) = 20.22, $p < .001$, eta squared = .099) and condition by year interaction term was also significant (F (7, 1660) = 12.96, $p < .001$, eta squared = .052). A decomposition of survey year within treatment condition effects revealed that there was a significant increase in positive perceptions of broadband service in each community, but the effect was stronger (t = 6.51, $p < .001$, eta squared = .025) in the community that benefited both from a Federal broadband grant and a public education effort than in either of the communities that had an infrastructure grant only (t = 3.69, $p < .001$, eta squared = .008; t =3.60, $p < .001$, eta squared = .008) or in the control community in which the grant was suspended (t = 3.14, $p < .05$, eta squared = .006). Broadband perceptions in the community that had both grant and education started at the lowest level among the four but were among the highest on the posttest, while perceptions increased at about the same rate in the other three communities. So, in answer to question 3b, community education, but not necessarily the provision of a broadband grant in itself, increased positive perceptions of broadband service compared to the control community.

Similar results were obtained when broadband usage intentions were the dependent variable, research question 3c. Both the overall analysis of variance (F (9, 2800) = 97.19, $p < .001$, eta squared = .238) and the year by condition interaction (F (7, 2800) = 12,198, $p < .001$, eta squared = .030) were significant. Within communities, the pre-post increase was again the largest for the one that had both a Federal grant and public education ($t = 6.06$, $p < .001$, eta squared = .013) compared to the two communities with only infrastructure grants ($t = 3.12$, $p < .05$, eta squared = .003; $t = 5.12$, $p < .001$, eta squared = .009) and the control ($t = 2.67$, $p < .05$, eta squared = .003). As was the case with broadband perceptions, the change in the grant-plus-education community took it from the lowest levels among the four counties on the pretest to the highest on the posttest. Regarding question 3c, a broadband grants alone had a differential impact in one case but not the other and there was an incremental benefit of adding public education.

To assess the impact of broadband adoption on personal economic development activities home Internet status was added to the preceding models and three-way interactions among year, location, and Internet status were examined along with a main effect for home Internet status. The analysis of variance in personal economic development activities was significant (F (25, 2816) = 30.28, $p < .001$, eta squared = .212) as was the interaction term (F (23, 2816) = 7.917, $p < .001$, eta squared = .056) and the main effect for home Internet status (F (2, 2816) = 40.101, $p < .001$, eta squared = .028). Personal economic development intentions increased linearly with home Internet status; that is, dial-up users had stronger intentions to improve their economic conditions than non-users and broadband users had stronger intentions than non-users in the three communities in which broadband grants were implemented but not in the control community. However, only the differences between non Internet users and dial up users were statistically significant. A decomposition analysis of the three-way interaction revealed that the interaction was due to a significant increase in personal economic development intentions in one of the "grant only" counties (Grant Only B) among non-users (t = 4.82, $p < .001$, eta squared = .008) and a significant decrease among broadband users in a second (Grant Only A) county (t = 2.23, $p < .05$, eta squared = .002). Personal economic development intentions also tended to decline among broadband users in the other grant-only county (t = 1.85, p = .06, eta squared = .001). Economic development intentions decreased in the control county among dial-up users (t = 2.26, $p < .05$, eta squared = .002). There were downward, although statistically insignificant, trends in personal economic development intentions among broadband users in the other three counties. Thus, the response to research question 4 was that while Internet adoption was related to personal economic development activities, neither the implementation of federal broadband grants nor community education activities intensified this effect.

Finally, there was a significant relationship between community satisfaction and an interaction between survey year, treatment, and Internet status when controlling for age and education (F (25, 2870) = 8.482, $p < .001$, eta squared = .069) and the three-way interaction was also significant (F (23, 2870) = 5.707, $p < .001$, eta squared = .040). The main effect for home Internet status was also significant (F (2, 2870 = 8.600, $p < .001$, eta squared = .006). In the three communities in which federal grants were implemented the satisfaction levels of dial-up users were significantly lower than those of non users and the same tended to be true in the control community (p = .055). The satisfaction of broadband subscribers was also lower than that of non-Internet users in each case. In two communities (Broadband Only B and Grant + Education) satisfaction levels of broadband adopters were higher than those of dial-up users. The three-way interaction was attributable to significant decreases in community satisfaction in one of the broadband grant-only communities (BB Grant Only A) among non- Internet users ($t = 3.38$, $p < .001$, eta squared = .004) and dial-up users ($t = 2.06$, $p < .05$, eta squared = .001). There was an increase in satisfaction among dial-up users in a second grant-only (BB Grant Only B) community ($t = 2.32$, $p < .05$, eta squared = .002). Save for the control community, there were (non-significant) downward trends for broadband users across survey waves. Thus, it could not be said from these data that broadband adoption had a positive effect on community satisfaction and neither the implementation of federal grants nor community education affected those results.

Discussion

While the present results offer some degree of validation for the current rural broadband strategy in the United States, they also pose challenges to some of the assumptions that underlie that strategy and raise questions about how its ultimate success might be judged. There was some evidence that federally funded broadband infrastructure projects lead to increases in broadband adoption and that there may be an incremental boost to adoption from providing public education about broadband service. However, broadband adoption also increased in a community where the federal grant was terminated and did not occur in another where the grant was implemented. Economic and broad quality of life impacts stemming from broadband development were not found. Thus, simply building “it” will not guarantee that the adopters will come, although combining infrastructure with community education may improve the chances that they will.

In another sense, if you build it they *will* come, “they” being competing broadband operators. That is, communities where federal infrastructure investments were implemented saw increases in broadband penetration attributable to network deployments by competing carriers who did not receive grants. It may even be that if you merely *offer* to build it they, the competitors, will also come. According to local sources, the threat of publicly subsidized competition stimulated telephone and cable companies to take pre-emptive action to enter rural markets in the two Texas counties. In the case of the community that served as the control condition in which the infrastructure grant was awarded but terminated before full implementation the gains in broadband adoption outpaced those in a similar community where the grant was enacted. In the Michigan county, cable and telco operators also opened broadband networks in small towns during the study period, although it is not certain that this development was speeded by the Community Connect grant award. However, the competing networks were confined to relatively densely populated areas in small towns. So, the question of broadband deployment in the countryside where fixed wireless operators might have a relative advantage is still open but so is their viability in an environment where wireline operators "cream skim" local in-town populations.

The viability of the broadband grant recipient may also affect adoption levels. In the grant-only Texas county the grantee experienced a declining market share amid reports of complaints about service quality, the growth in broadband penetration was weak compared to the grant-only county in Michigan. There, the Community Connect grant recipient was able to hold broadband market share across years despite the entry of formidable wireline competitors including Comcast and AT&T and attract favorable mention in the FCC's strategic report.

The incremental impact of community education efforts in the Kentucky county were all the more remarkable considering that they raised broadband penetration to well above the average for rural areas in that state as a whole, a statewide average that was considerably below that of the other two states included in the study (Table 1). By the end of the study broadband penetration in the Kentucky county was within sampling error of the broadband penetration level in urban Kentucky, suggesting that community education efforts combined with federal infrastructure grants might succeed in closing the urban-rural broadband gap.

Limitations

An important limitation of the present study is that counties were the unit of analysis, while the impacts of broadband grants may be concentrated in smaller areas. For example, the Huron County grant extended service to areas that were beyond the reach of wireline competitors and previously unserved by broadband. No guidance was given to respondents when judging whether their service was high speed or not, although high speed service was distinguished from dial up by specifying it as "always on," so the impact of high quality broadband service compared to inferior service (e.g., under 768 Kbps) could not be determined. The four communities in the study were selected for their proximity to the home universities of the principal investigators and so do not represent all rural communities.

For Future Research

Future efforts to evaluate the impacts of broadband grants and public information campaigns created by the ARRA should focus on smaller geographic entities than in the present research. A parallel broadband mapping initiative is intended to provide information at the census block level. Economic outcomes have been found to be sensitive to the unit of analysis. Finely-grained analyses at the zip code level yielded significant results that county-level analyses did not; for example (Gillett et al., 2006). However, until now only imprecise broadband access data has been available for zip codes (from FCC Form 477) that indicates only if broadband is present somewhere in a zip code. Thus, the ARRA initiatives offer the opportunity to examine the impacts of broadband infrastructure investments at an unprecedented level of precision. Detailed information about the availability, penetration, speed and cost of service at the census block level will allow new questions about the impacts of the quality and price of service to be asked.

However, even with detailed infrastructure deployment data, questions about the mechanisms of economic growth flowing from home broadband adoption will likely remain. For example, finding a relationship between median household income and broadband penetration at the census block level will not help us understand exactly what is going on in homes that improves economic outcomes. Time series analysis will help to rule out the competing hypothesis that higher income causes broadband adoption but panel or experimental studies with individuals as the units of analysis are also called for. For example, individuals enrolled in community education activities stressing online business development could be followed over time to determine how many ultimately launch online businesses.

Non-economic outcomes are also important for rural communities since they affect the depletion of the most essential of all of a community's resources, its people (DeJong & Fawcett, 1981). Fine-grained analyses (e.g., census block level) that compare community satisfaction indices and other gross measures of well-being between areas that are well served by broadband with those that are less well served might yield more valid results than the present study. However, a reality check on rosy predictions about the impact of rural broadband on community life (e.g., in FCC, 2009) may also be in order. Controlled evaluations should be targeted to the specific communication objectives and intended audiences of community education campaigns and data about exposure to specific campaign elements should also be obtained.

Judging from the perceptions of broadband that were unchanged over the course of the current study, there is more to be done to stimulate broadband adoption in rural America. There were minimal changes in beliefs about the usefulness of broadband for listening to the radio, downloading music and videos, making phone calls, starting a home business, improving health care, or sharing pictures. These are possibilities with great potential appeal to consumers that might lure new broadband adopters but which providers concerned about bandwidth consumption or the possibility of cannibalization of conventional voice and video services may not emphasize. Public-spirited, consumer-oriented community education efforts might fill this gap. The limited growth in broadband awareness found here may indicate another gap in broadband marketing which commercial providers may quite naturally overlook: the possibility of convincing those not currently online that there may be value in broadband not present in dial-up service. An analysis of those considering new broadband subscriptions found that nearly two-fifths of dial-up subscribers intended an upgrade. However, 5 percent of those without any home Internet connection also had plans for starting broadband subscriptions, a segment of the population that should perhaps not be overlooked.

Thus, rural infrastructure grants in themselves do not guarantee expanded consumer adoption of broadband Internet service. Federal grants may be the most effective when they stimulate private sector competition and are paired with community education efforts. Rural infrastructure projects emanating from the Recovery Act afford new opportunities to understand the impact of broadband Internet service on individuals, communities, and the economy as a whole. The challenge remains to understand how to maximize the positive social impacts of the broadband construction projects dotting America.

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Table 1. Community Profiles

	County			
Variable	Pike, KY	Huron, MI	Zapata , TX	Zavala, TX
Treatment Condition	Grant + Campaign	Grant Only A	Grant Only B	Control
2008 Population Estimate[1]	65,331	32,805	13,847	11,678
Percent Population Change 2000-2008	-5.0	-9.1	13.7	.7
Percent Non-white[1]	1.8	2.1	1.6	2.4
Percent Hispanic[1]	.8	2.0	88.3	89.9
Median Household Income[1]	$32,382	$38,687	$30,017	$21,346
Percent below poverty[1]	20.8	12.7	33.4	40.7
Percent less than high school graduate[1]	38.2	22.7	46.9	56.4
Percent 65 or over[1]	13.4	21.6	13.3	11.2
Average 2008 unemployment rate[2]	5.9	9.3	5.6	10.3
State Rural Internet Penetration[3]	49.8	61.7	55.3	55.3
State Rural Broadband Penetration[3]	29.6	36.5	36.6	36.6
Urban Influence Code[4]	11	11	6	9

[1] Source: State and County Quick Facts. Available: http://quickfacts.census.gov/qfd/index.html

[2] Source: Bureau of Labor Statistics, Labor Force Data by County, 2008 Annual Averages. Available: ftp://ftp.bls.gov/pub/special.requests/la/laucnty08.txt

[3] Source: October, 2007 Current population survey. Available: http://www.ntia.doc.gov/reports/2008/Table_HouseholdInternet2007.pdf

[4] Source: Economic Research Service. Available: http://www.ers.usda.gov/Data/UrbanInfluenceCodes/2003/

Table 2. Broadband Adoption at Home by Year and Location

Condition	Mean	Std. Error of the Mean	B	Std. Error B	Wald Chi-Square	Odds Ratio
(Intercept)	---	---	-3.106	.2925	112.720 **	.045
Grant + Campaign Posttest	.45 [a]	.031	1.951	.1951	99.99 **	7.033
Grant + Campaign Pretest	.12 [c,e,g]	.017	.132	.2216	.356	1.141
BB Grant A Posttest	.40 [a,f]	.027	1.755	.1907	84.746 **	5.786
BB Grant A Pretest	.15 [b,c,d,g]	.018	.415	.2063	4.052 *	1.515
BB Grant B Posttest	.23 [c,d,e,f]	.022	.940	.1926	23.819 **	2.560
BB Grant B Pretest	.18 [b,c,d,e,f]	.019	.608	.1967	9.554 *	1.837
Control Posttest	.22 [b,c,d,e,f]	.023	.916	.1937	22.378 **	2.500
Control Pretest	.10 [c,g]	.014	0	---	---	1
Age in years (covariate)	12.50	3.55	-.031	.0030	107.699 **	.969
Education in years (covariate)	50.18	17.64	.202	.0165	150.224 **	1.224

Note: Common superscripts indicate equal means among conditions. * p < .05 ** p < .001

Table 3. Broadband Awareness by Year and Location

Condition	Mean	Std. Error of the Mean	B	Std. Error B	Wald Chi-Square	Odds Ratio
(Intercept)	---	---	-2.198	.2881	58.204 **	.111
Grant + Campaign Posttest	.78 [a]	.026	1.692	.1964	74.223 **	5.428
Grant + Campaign Pretest	.69 [a]	.031	1.205	.1881	41.028 **	3.333
BB Grant A Posttest	.74 [a]	.024	1.473	.1779	68.508 **	4.361
BB Grant A Pretest	.71 [a]	.026	1.324	.1777	55.499 **	3.758
BB Grant B Posttest	.54 [b,c,d]	.031	.553	.1723	10.302 **	1.739
BB Grant B Pretest	.43 [b,c,d,e]	.029	.152	.1671	.823	1.164
Control Posttest	.53 [b,c,d]	.033	.524	.1754	8.920 *	1.688
Control Pretest	.40 [c,e]	.029	0[a]	---	---	1
Age in years (covariate)	50.17	17.64	-.050	.0029	289.135 **	.951
Education in years (covariate)	12.50	3.55	.345	.0187	339.058 **	1.412

Note: Common superscripts indicate equal means among conditions. * p < .05 ** p < .001

[i] In the next year I will…place phone calls from the Internet from my home, have high speed Internet at home, use a high speed Internet connection outside my home, install a wireless computer network at home.

[ii] From what you may have heard about high-speed Internet service, how much do you agree or disagree. It is not worth the cost (reflected), It would improve my life, There is nothing I need it for (reflected), I could take online courses more easily, I could play multi-user games over the Internet, It is easy to install, I haven't seen for myself what it can do (reflected), I haven't heard good things about it from the people I know (reflected), The computer I use isn't capable of high speed Internet (reflected), It's not available where I live (reflected). It's not worth the hassle (reflected).

[iii] How satisfied are you with: Living in my community, My opportunities for further education, The recreational services and opportunities available, The medical services available to me, The shopping facilities in my community, My employment opportunities, My opportunities to participate in the local government, The programs for youth in my community, My cultural opportunities, Educational opportunities for young people, The quality of streets and roads.

[iv] In the next year I will…Start a small business; Work from home using the Internet; Run a business from my home, Take a course through the Internet, Complete a degree or training program.